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EXAMINER	
RUGGLES, JOHN S	

ART UNIT	PAPER NUMBER
1756	

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Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)
	09/963,527	OGATA ET AL.
	Examiner	Art Unit
	John Ruggles	1756

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If the period for reply specified above is less than thirty (30) days, a reply within the statutory minimum of thirty (30) days will be considered timely.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133).
- Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on 25 August 2003.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) 16-29 is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) 16-29 is/are rejected.

7)☒ Claim(s) 16-29 is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☒ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on 25 August 2003 is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

11)☐ The proposed drawing correction filed on _____ is: a)☐ approved b)☐ disapproved by the Examiner.

If approved, corrected drawings are required in reply to this Office action.

12)☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. §§ 119 and 120

13)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____ .

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

14)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. § 119(e) (to a provisional application).

a) ☐ The translation of the foreign language provisional application has been received.

15)☐ Acknowledgment is made of a claim for domestic priority under 35 U.S.C. §§ 120 and/or 121.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO-1449) Paper No(s) _____ .
4) ☐ Interview Summary (PTO-413) Paper No(s). _____ .
5) ☐ Notice of Informal Patent Application (PTO-152)
6) ☐ Other: .

DETAILED ACTION

Election/Restrictions

Applicants' cancellation of all previously non-elected claims 1-15 in an amendment filed 25 August 2003 as Paper No. 9 is acknowledged.

Drawings

The newly corrected Figures 4 and 9 on replacement drawings sheets 4/15 and 8/15, respectively, were received with Paper No. 9 on 25 August 2003 in response to the previous objections of Paper No. 8. These newly corrected drawings are accepted and the previous objections are now withdrawn.

Specification

Applicants' change of the title, as previously suggested, to --Resist Pattern Forming Method--, is acknowledged.

The submission of a substitute specification to correct numerous errors in the original specification is appreciated. However, the specification is still replete with terms that are not clear, concise and exact. The specification should again be revised carefully in order to comply with 35 U.S.C. 112, first paragraph. Examples of some remaining unclear, inexact or verbose terms found in the marked up version of the substitute specification are: (1) at lines 5, 9, and 23 on page 5 and at line 19 on page 7, "at least for one of" should be corrected to --at least one of--; (2) at lines 3-4 on page 7, "the present invention a resist pattern forming method, comprises the

steps of," should be rewritten to be grammatically correct (e.g., to --the present invention of a resist pattern forming method, which comprises the following steps: --, etc.); and (3) at lines 14-15 on page 11, the currently amended phrase "will not be explained" in reference to the developing unit 3B mischaracterizes the following description of the elements of this developing unit 3B, as shown in Figure 4, starting at line 16. Note that due to the number of errors, those listed here are merely *examples* of the changes required in the substitute specification and do *not* represent an exhaustive list thereof.

Appropriate correction is required. An amendment filed making all appropriate corrections must be accompanied by a statement that it contains no new matter.

Applicants' shortening of the abstract is appreciated, in an attempt to meet the previous objection to the abstract as having more than 150 words. However, the amended abstract still has more than 150 words and it is further noted that the abstract is written only in terms of the non-elected apparatus embodiment, which has now been cancelled from the claims. The abstract would be more representative of the instant invention as currently claimed if rewritten in terms of the remaining method. Correction is again required in accordance with MPEP § 608.01(b).

Claim Objections

Currently amended versions of the claims have overcome most of the previous objections to the pending claims. The remaining objection not yet overcome is restated below along with new objections necessitated by amendment.

Claims 16-29 are objected to because of the following informalities: (1) in lines 4-5 of claim 17, lines 6-7 of claim 19, line 5 of claim 21, line 8 of claim 22, line 4 of claim 23, and line 4 of new claim 28, "at least for one of" must be corrected to --at least one of--, to be grammatically correct; (2) in lines 11-12 of step (e) in claim 16, "when the set value of each of the parameters subjected to amendment: the rotating speed," should be rewritten in proper form (e.g., to --when the set value of each of the parameters <u>is</u> subjected to amendment <u>of</u>: the rotating speed,--, etc.); (3) in lines 15-16 of step (e) in claim 16, "alignment of exposing portion" should be corrected to --alignment of <u>the</u> exposing portion-- to be grammatically correct and "substrate, is amended." should be simplified to --substrate.--, because the foregoing phrases follow "amendment:" and are therefore already understood to be amended; and (4) in line 5 of claim 28, "parameters subject to the amendment, the rotating speed" should be changed to --parameters subject to the amendment: the rotating speed--, to be grammatically correct. Claims 17-29 are dependent on claim 16. Appropriate correction is required.

Claim Rejections - 35 USC § 112

Currently amended versions of the claims have overcome the previous rejection under the first paragraph of 35 U.S.C. 112 and most of the previous rejections to the pending claims under the second paragraph of 35 U.S.C. 112. The remaining rejections under the second paragraph of 35 U.S.C. 112 are restated below along with new rejections necessitated by amendments to the claims.

The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter, which the applicant regards as his invention.

Claims 16-29 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

In step (a) of claim 16 for forming a resist film, it is still unclear whether "a base film being formed" found at line 2 refers to (1) the resist film or (2) an underlying base film already on the substrate now being coated by the resist. Lines 13-14 on page 20 of the instant substitute specification state, in part, "...the reflection ratio of the base film measured <u>before</u> resist coating" (emphasis added). This suggests the latter interpretation (2). However, claim 16 must still be amended in response to this rejection. Further, in step (d) of claim 16, the phrase "an accuracy that the base film matches with a resist pattern" is unclear since it is not apparent how such a comparison could be made unless the base film had already been patterned (etched) through the resist, but such patterning or etching of the base film has not yet been claimed (this comparison lacks antecedent basis). Claims 17-29 are dependent on claim 16.

In line 3 of claim 18, the phrase "the measured data of the base film" is unclear. Claim 18 depends on claim 16 and step (d) of claim 16 recites alternative measuring of data of at least one measurement item selected from a list that includes "a reflection ratio and a film thickness of the base film". Nevertheless, applicants are requested to clarify whether this phrase in claim 18 is really meant to include one or both of these measured data items of the base film. Further, it is noted that this amended change to claim 18 was unmarked from the originally filed version, which recited "the measured data of the thickness of the resist film". The fact that the change was unmarked suggests that this amendment may have been unintentional and applicants are

therefore requested to clarify what is intended by this phrase. For the purpose of this Office action and to advance prosecution of this application, this phase in claim 18, as currently amended, has been interpreted based on the plain meaning of step (d) in claim 16, on which claim 18 depends, as --the reflection ratio ***and*** the film thickness of the base film--. However, claim 18 must still be amended in response to this rejection, especially if applicants intend some other interpretation of claim 18, as currently amended.

Claims 22-23, 26, and 28 lack antecedent bases for "the etched line width" (line 6 in claim 22, line 2 in claim 23, line 2 in claim 26, and lines 2-3 in claim 28). Line 2 of claim 26, and line 3 of claim 28 also lack antecedent bases for "the etching". Claim 29 is dependent on claim 28.

In the formula of claim 24, it is unclear what the recited symbols "μ_1", "μ_2", "μ_3", and "μ_4" are meant to represent. Lines 2-3 on page 43 of the substitute specification calls these symbols "coefficients (contribution degrees)". Accordingly, the phrase "the contribution degree and the film thickness of the resist is," found at lines 2-3 should be rewritten to incorporate this necessary information, while eliminating repetition (e.g., by replacing this phrase with --the contribution degree is represented by coefficients μ_1, μ_2, μ_3, and μ_4,--, etc.). Also, claim 24 is not a complete sentence. It is further noted that while applicants have changed "an invariable" in the marked up substitute specification to --a constant-- in reference to the symbol "α" (e.g., at line 2 on page 43, etc.), "an invariable" is recited in the last line of new claim 24 in reference to "α". Applicants should use the same term in the claims that is used in the specification, as amended.

Claim Rejections - 35 USC § 102

The previous rejection of claims 16-19 and 22 under 35 U.S.C. 102(b) as being anticipated by Nakayama, et al. (US Patent 5,747,201) is withdrawn in view of current amendments to these claims.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 16-23, 25, and 28-29 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakayama, et al. (US Patent 5,747,201) in view of Batchelder, et al. (US Patent 4,647,172), further in view of Auda, et al. (US Patent 5,139,904), further in view of Phan, et al. (US Patent 5,985,497), further in view of Lewis, et al. (US Patent 5,308,447), further in view of Sanada (US Patent 5,843,527), further in view of Yoon, et al. (US Patent 5,283,141), and further in view of Bae (US Patent 5,766,809).

Nakayama teaches a process for controlled forming and treating of a thin film (coating a photoresist (resist) using a spinner (spin coating) at column 8, line 22 and column 12, line 17) on a wafer (substrate) with or without an undercoating (column 9, line 41, base film). This spin coating is understood to encompass supplying a resist solution through a nozzle onto a substrate held by a horizontally rotating holder to spread the resist solution by centrifugal force over the substrate (instant claim 16, step (a)). An optical property measuring system (instant claim 16,

step (d) for measuring data) is used to control (instant claim 16, step (e) for amending a set value based on measured data) the rotating frequency (instant claim 16, step (e) for amending rotating speed) of the spinner during spin coating of the resist, temperature in a baking furnace (instant claim 19 for amending heating of the resist at a predetermined temperature), or resist baking time (instant claim 19 for amending heating of the resist for a predetermined time, column 12, lines 12-24). The optical measuring system detects reflectivity of the undercoat (instant claim 16, step (d) and instant claim 17 for measuring the reflection ratio of the base film), resist film thickness (instant claim 16, step (d) and instant claim 18 for measuring resist film thickness), and reflectivity of the resist which are input into an optimum exposure detecting system to determine the resist index of refraction and obtain an optimum exposure energy composed of the irradiation illuminance (intensity of the ray radiated to the exposing portion (of the resist) on the substrate, instant claim 16, step (e) and instant claims 17-18 for amending exposure intensity) and the exposure time (time period for the exposure, instant claim 16, step (e) and claims 17-18 for amending exposure time) at column 9, lines 36-55. The thickness of resist obtained is used to calculate the variation with time of the resist index of refraction to adjust (amend) the exposure properties (exposure intensity and time). A television camera is connected to an X-Y stage for alignment of a resist-coated wafer (instant claim 16, step (e) for amending alignment of exposing portion of the substrate) in an exposure apparatus controlled by measured optical properties (column 9, line 56 to column 11, line 13). The control of exposure through a patterned reticle (mask) is described at column 13, lines 7-67. This exposure process is understood to encompass disposing the resist coated substrate at the focus point of a lens in the exposing portion having a light source and the lens by radiating a ray of a controlled (predetermined) intensity for a

controlled (predetermined) time period, using a predetermined pattern mask (instant claim 16, steps (b) and (e) and instant claims 17-18 for amending the exposure intensity and time period). Developing of the exposed resist is controlled by optical property measurements for the resist (column 8, line 54 to column 9, line 3). The developing is understood to encompass supplying a developing solution of a predetermined temperature onto the exposed resist on the surface of the substrate and leaving the developing solution on the resist for a predetermined time (instant claim 16, steps (c) and (e) and instant claim 17 for amending the developing time period and temperature of developing solution). Nakayama also suggests controlling subsequent etching using optical properties measured before, during, or after film formation in the abstract, Figure 4, and specifically states this intention in claim 3 (column 15, lines 59-62). Controlling the subsequent etching is understood to encompass etching the substrate by supplying an etching gas of a predetermined composition ratio to the substrate for a predetermined time period (instant claim 22 for amending etching time and gas composition ratio).

While teaching a photolithographic process involving control or amendment of many of the same parameters in accordance with some of the same type of measured data as are recited in the instant claims, Nakayama does not teach all the claimed alternatives and recited limitations in these instant claims. In particular, Nakayama does not specifically teach measuring at least one of the following: base film thickness, line width after developing, accuracy of the base film pattern as compared to the resist pattern, surface defects, and etched line width. Nakayama also does not specify using each of these measurements in accordance with the relative degree to which each contributes to an amended parameter for amending at least one of the following:

degree of acceleration and/or nozzle position during spin coating, and distance between focus point and substrate during exposure.

Batchelder shows an automatic process for coating a resist on a semiconductor wafer, patterned exposure of the resist, spin developing of the exposed resist pattern, and etching through the developed resist pattern (column 1, line 66 to column 2, line 37). Control (amendment) of the developing time is calculated based on a predictable scaling factor "A" at column 4, lines 22-28. The scaling factor "A" is determined based on microscopic observation (optical measurement) of line widths after developing as shown in Figure 1 and described at column 6, lines 3-15. The use of scaling factor "A" is understood to be equivalent to determining the contribution degree of developing time (controlled by amendment) to obtain a desired line width after developing (measured). This process of using variable controlled or amended developing time results in improved consistency of measured line widths over that using a fixed development time. Similar improvements were also observed with respect to variations in resist coating thickness (measured) and resist baking or heating time (controlled or amended, column 6, lines 42-55, instant claim 16, steps (d) and (e) for measuring resist coating thickness or resist line width after developing in order to control amendment of resist heating time or resist developing time, respectively). The fact that similar improvements were observed for controlled amendment of each parameter (e.g., resist heating time, resist developing time, etc.) using different degrees of contribution derived from predetermined scaling factors for each measured variable (e.g., resist coating thickness, resist line width after developing, etc.) suggests that relative degrees of contribution for each measured variable would be expected to result in

even better control of each parameter for optimization of a photolithographic process having similar steps.

Auda describes a method of producing high resolution and reproducible patterns (typically polysilicon ultra-fine lines, in the abstract). A polysilicon layer (base film) on an insulating substrate is coated with a standard photoresist (resist) by conventional techniques as explained in respect to Figure 1A which is described to include spin coating of the resist (column 2, lines 12-33 and column 5, lines 35-40). The resist is imaged with UV radiation through an appropriate (predetermined) mask, post-exposure baked (heated), and developed to produce the resulting structure shown in Figure 2B and described at column 5, lines 40-45. This is followed by either (1) first isotropic etching by high pressure RIE of the resist pattern 17a to simultaneously reduce the resist thickness and line width to 17a′ as shown in Figure 2C, then anisotropic (directional) etching by low pressure RIE of the polysilicon layer (base film) using the reduced resist image and removal of the remaining resist as shown in Figure 2D (column 5, line 50 to column 6, line 13) or (2) first anisotropic (directional) RIE of the polysilicon (base film) using the original (unreduced) resist image as shown in Figure 3B and removal of the remaining resist to form the polysilicon (base film) pattern 16b as shown in Figure 3C, then isotropic RIE of the polysilicon (base film) pattern to simultaneously reduce the base film pattern thickness and line width to form 16b′ as shown in Figure 3D (column 6, lines 18-42). The isotropic etching of the resist pattern is optically measured to control (amend) this etching process to obtain the desired resist film thickness and line width (column 6, lines 1-7). It is also paramount that base film etched line width and thickness be accurately monitored (optically measured) during etching to control (amend) etching conditions (etching time for a specified gas

composition) at column 6, lines 38-41 and column 7, lines 4-11 (instant claim 16, step (d) and instant claim 17 for measuring base film thickness, instant claim 22 for etching with an etchant gas of a predetermined composition for a predetermined time, and instant claims 22-23 for measuring etched line width).

Phan discloses a method for reducing defects in a semiconductor lithographic process by measuring defects using a scanning electron microscope (SEM) to review and classify the defects into different types and causes (abstract and column 3, lines 26-30). A pattern is formed on a first silicon wafer using a prescribed lithography fabrication processing specification, inspecting (measuring) the pattern for defects, developing an alternative (amended) processing specification to correct for measured defects, using the amended process to form a pattern on a second silicon wafer, then comparing the first and second patterns, and changing (amending) the lithographic process based on the comparison (resulting from defect measurement, column 2, lines 30-44). The comparison of defect measurements (to determine if the amended process improves yield with a comparable parameter quality) includes those in critical dimensions (CD, understood to encompass base film thickness and etched line width), resist profile (resist film thickness and line width after developing), etch bias (understood to be indicative of the accuracy of an etched base film pattern as compared to a corresponding resist pattern used as an etching mask), and electrical properties is disclosed at column 5, line 63 to column 6, line 5 (instant claim 16, step (d) for measuring base film thickness, resist film thickness, line width after developing, accuracy of base film pattern as compared to resist pattern, and surface defects; instant claim 16, step (e) for amending developing time; instant claim 17 for measuring base film thickness and amending developing time; instant claim 18 for measuring resist film thickness

and amending developing time; instant claim 19 for measuring line width after developing and amending developing time; instant claim 21 for measuring defects and amending developing time; and instant claims 22-23 for amending developing time based on etched line width). This comparison and subsequent amendment optimizes the lithography process by reducing defects (column 2, lines 8-9). For optimization by amending properties based on measured defects, Phan discusses changing (amending) developing conditions (specifically, developing time) at column 7, line 46 to column 9, line 3.

Lewis teaches a process of controlled (amended) positioning of developer nozzles 21 and 23 at different distances from the center of rotation over a spinning resist coated article (wafer) based on optical measurements (by photodetectors to measure completion of developing -- could involve measurement of line width after developing) during the process as shown in Figure 1 and described at column 3, line 45 to column 4, line 55. This is understood to be equivalent to amendment of a nozzle position for resist spin coating based on an optical measurement (e.g., resist film thickness, etc.; instant claim 16, step (d) for measuring resist film thickness; instant claim 16, step (e) for amending nozzle position during spin dispensing or coating; and instant claim 23 for amending nozzle position during spin dispensing or coating). Etching can also be accomplished by a liquid etchant applied to a spinning substrate in much the same controlled manner (by amendment based on a measurement) as spin coating a resist on a substrate or developer on an exposed resist (column 7, lines 55-57). Plasma dry etching can be conducted using optical measuring of etching progress (e.g., by measuring etched line width, etc.) to control (amend) the etching process (e.g., to change gaseous etchant composition ratio, control etching time, etc.) as shown in Figure 5 and described at column 7, line 57 to column 8, line 21 (instant

claims 22-23 for measuring etched line width and instant claim 23 for amending etching time and etching gas composition ratio). Temperature of the developer (solution) or, alternatively, an etchant supplied through nozzles 21 and 23 is also controllable (Figures 1-2, column 8, lines 58-62; instant claim 16, step (c) for supplying a developer solution at a predetermined temperature; instant claim 16, step (e) and instant claims 19, 21-23 for amending developer solution temperature). The rotation speed and linear motion of the substrate can be controlled along with a process variation for rotating distribution nozzles to selectively treat only portions of the rotating substrate (column 9, lines 3-12; instant claims 19 and 22 for amending rotation speed of the substrate during resist spin coating). Both the flow rate and direction of individual nozzles can be controlled (column 9, lines 19-21; instant claim 16, step (e) and instant claims 21 and 23 for amending nozzle position during resist spin coating). Developer (solution) or etchant composition can be controlled by selective mixing of plural components in response (amended by) system controllers 55 or 103 as shown in Figures 1 or 2 and described at column 9, lines 21-24 (instant claim 22 for etching by an etching gas having a predetermined composition ratio for a predetermined time period and instant claim 23 for amending the etching gas composition ratio and/or etching time based on measured etched line width). Uniformity is obtained by controlled correction (amendment) for variations (measured) across the surface of a substrate during processing (column 1, lines 9-13 and column 2, lines 18-24).

Sanada discloses a method of spin coating photoresist (resist) on a horizontal substrate (semiconductor wafer, column 1, lines 7-11, column 18, lines 50-52, as shown in Figure 4). Back rinse nozzles 11 remove extraneous resist from the backside (underside) of the substrate and a resist supply nozzle 5 delivers resist to the substrate during coating. Acceleration

(increasing rotation speed) applied after beginning centrifugal spreading leads to the curved coating patterns shown in Figures 6C-D, due to inertia of the resist during increasing rotation of the substrate as described at column 20, lines 25-56 (instant claim 16, step (e) for amending rotating substrate degree of acceleration and nozzle position during resist spin coating; instant claims 17-19 and 22 for amending rotating substrate degree of acceleration during resist spin coating). As a result, a desired resist film thickness is formed on the substrate wafer by using a drastically reduced supply of resist solution (column 21, lines 24-26). This reduces cost (because less resist is wasted) and improves throughput for manufacture of semiconductor elements and devices (column 23, lines 43-53). Column 25, lines 48-58 also disclose use of a movable resist dispensing nozzle, adjustable (amendable) based on resist viscosity, wafer size and surface condition.

Yoon shows a photolithography method and corresponding apparatus controlled (amended) by measuring optical characteristics of the resulting latent image. Adjustment (amendment) means such as a computer 104 adjusts (amends) control parameters according to information obtained from observations (measurements) of latent images by a phase contrast microscope 110 as shown in Figure 1 and described at column 3, lines 8-11. The latent image (characterized by image line width at column 3, lines 58-59) is discernable as changed "optical thickness" in the resist due to changed refractive index in the exposed pattern portions, depending on the length (time) and intensity of exposure (column 3, lines 28-53). The image measurement is alternatively described as occurring while exposure of the resist is actually taking place to provide in-situ monitoring/observation for correction (amendment) of the exposure process (column 4, lines 15-19). As shown in Figure 3 and described at column 4,

lines 49-54, the image measurement controls adjustment (amendment) of exposure conditions including numerical aperture, exposure time, wafer position, focus (encompasses distance between focus point and substrate during exposure), and illumination coherence (instant claim 16, step (e) for amending exposure intensity and time, and distance between focus point and substrate during exposure; instant claim 19 for amending exposure intensity or distance between focus point and substrate during exposure; instant claim 21 for amending exposure intensity or distance between focus point and substrate based on measured line width (to reveal defects); and instant claims 22-23 for amending exposure intensity, exposure time, or distance between focus point and substrate during exposure based on measured line width (understood to be indicative of line width after etching)). Column 6, lines 52-55 state that the in-situ latent image measurement allows quick adjustment (amendment) of the exposure stepper apparatus for each new mask layer or batch of wafers, without having to develop the exposed resist (shows that measuring the latent image line width is an appropriate substitution for measuring the line width after developing, instant claim 16, step (e) and instant claim 19 for measuring line width after developing).

Bae describes a method for testing an overlay in a semiconductor device for alignment (of substrate exposing portion). An etch layer (base film) is coated on a semiconductor wafer, then etched through a photoresist (resist) film pattern to form outer alignment marks 42 shown in Figures 9-10 and described at column 5, lines 50-60. The first resist is removed, and another resist layer 45 is coated over the marks 42, exposed through a patterned mask (aligned with the etched marks 42 on the substrate), and developed to form an inner mark including an island portion 43 inwardly spaced from the outer marks 42 by a desired width and a land portion 44 to form an overlay measuring mark shown in Figure 10 and described at column 6, line 61 to

column 7, line 5. The overlay is then used for an accurate alignment measurement (column 7, lines 6-10) (instant claim 20 for measuring accuracy of base film pattern as compared to resist pattern and amending alignment of the exposing portion of the substrate).

It would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the controlled (amended) photolithographic process based on measured data taught by Nakayama as discussed above with controlled (amended) resist heating time or resist developing time to obtain improved consistency of resist coating thickness or resist line width after developing, respectively, and that using relative degrees of contribution for each measured variable would be expected to result in even better control of each parameter for optimization of a photolithographic process having similar steps as suggested by Batchelder; and/or with controlled (amended) etching conditions based on relative degrees of contribution for measured base film thickness or accuracy of etched line width (as compared to the resist pattern) to produce high resolution and reproducible patterns as described by Auda with incorporation of the relative degrees of contribution concept for each variable as suggested by Batchelder. Anisotropic (directional) etching of the base film using the resist image (pattern) along with line width measurements of the resist pattern and corresponding etched base film as described by Auda would also be expected to provide parameters for resulting control (amendment) of the etching process along with incorporation of the relative degrees of contribution concept for each variable as suggested by Batchelder (instant claim 16, step (d) and instant claim 28 for measuring accuracy of an etched base film pattern as compared to the resist pattern to amend a process parameter and instant claim 23 for measuring etched line width for amending the etching time period and/or etching gas composition ratio). It would also have been obvious to combine the

controlled (amended) photolithographic process based on measured data taught by Nakayama, Batchelder, and/or Auda as discussed above with defect correction and reduction (by an amendment based on defect measurement) for optimizing the photolithography process as disclosed by Phan.

Furthermore, it would have been obvious to one of ordinary skill in the art at the time the invention was made to combine the controlled (amended) photolithographic process based on measured data taught by Nakayama, Batchelder, Auda, and/or Phan with controlled (amended) dispensing nozzle position (for resist spin coating or developing solution spreading), developer solution temperature, line width after developing, or etching of the substrate (or base film, by amending the etching time and/or the etching gas composition ratio) based on measured resist film thickness or etched line width for resulting uniformity even when surface variations occur during processing as taught by Lewis; and/or with controlled (amended) degree of acceleration during resist spin coating based on measured resist film thickness to achieve reduced cost and improved throughput as disclosed by Sanada. It would also have been obvious to combine the controlled (amended) photolithographic process based on measured data taught by Nakayama, Batchelder, Auda, Phan, Lewis, and/or Sanada as discussed above with controlled (amended) distance between the focus point and the substrate during exposure, exposure intensity, or exposure time based on measured line width (latent image line width substitutes for line width after developing) to allow quick in-situ amendment of exposure conditions, even before developing as shown by Yoon and/or amending alignment of the exposing portion of the substrate based on measured accuracy of the etched base film as compared to the resist pattern for accurate alignment as described by Bae. All of these photolithographic process combinations

would also be expected to benefit from incorporation of the relative degrees of contribution concept for each variable as suggested by Batchelder and described above. As a further extension of this approach, one of ordinary skill in the art at the time the invention was made would logically have given priority to amendment of each parameter having a greater effect (higher degree of contribution) on the resulting measured outcome (measured variable) in order to more rapidly approximate optimized process conditions (e.g., by making largest amendments first, then lesser amendments, all the way down to the amendment having the lowest relative degree of contribution in the corresponding measured variable, etc., instant claim 25). It is also known to clean extraneous or defective portions of resist from the substrate by rinsing or dissolution as disclosed by Sanada and could be combined with subsequent replacement of this previous resist determined to be defective by another layer of resist for patterning without defect as disclosed by Bae (instant claim 29). This is because these references relate to the same art of semiconductor manufacturing involving resist processing.

Claims 26-27 are rejected under 35 U.S.C. 103(a) as being unpatentable over Nakayama in view of Batchelder, further in view of Auda, further in view of Phan, further in view of Lewis, further in view of Sanada, further in view of Yoon, further in view of Bae, and further in view of Robinett (US Patent 5,964,980).

While teaching photolithographic semiconductor processes involving measuring of variables and corresponding amendments to parameters in accordance to relative contribution degrees of these parameters, the references previously applied and discussed above do not

specify either (1) that an alarm is outputted when the measured etched line width is over a permissible range or (2) that an operator performs an amendment manually.

Robinett discloses a method and system for controlling etching during semiconductor processing, which involves determining if the etching process is out of tolerance (column 1, lines 5-7). During etching, an optical wavelength intensity detector and sampler unit 24 periodically samples continuous light intensity (of the etched profile, which is understood to include etched linewidth as well as etched depth) and provides a series of stepped intensity signals to an intensity-to-digital converter 26, which in turn provide digital output code words for each sample intensity signal, both as shown in Figure 3. The values of the digital code words are called "counts" and are proportional to the intensity signals. These counts are then processed by software in a computer system 56 as shown in the flow chart of Figure 6 (column 4, lines 38-53). Block 94 in this figure represents testing whether a quality number for a particular wafer has exceeded a predetermined limit and block 96 represents sounding of an alarm to immediately notify an operator to immediately investigate whether a measured process variable has changed (e.g. variation of the base film thickness, etc., column 6, lines 13-19) to allow immediate manual amendment of parameters in the process.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to have combined the Robinett measurement of etched line width either during or after etching and outputting an alarm to an operator to allow immediate investigation and immediate manual amendment of parameters, presumably each in accordance with corresponding contribution degrees (instant claims 26-27) as taught by the other references cited above (e.g., in view of Batchelder, etc.). This is because all of these references relate to the same art of

lithographic processing for semiconductor device manufacture involving measuring process variables and amending corresponding parameters, each in accordance with its relative contribution degree for amending of the process variables.

Allowable Subject Matter

Claim 24 is objected to as being dependent upon a rejected base claim, but would be allowable if rewritten in independent form including all of the limitations of the base claim and any intervening claims.

Claim 24 would be allowable if rewritten to overcome the rejection(s) under 35 U.S.C. 112, second paragraph, set forth in this Office action and to include all of the limitations of the base claim and any intervening claims.

The following is a statement of reasons for the indication of allowable subject matter: while a resist film thickness formed by spin coating is known to depend on the temperature of resist liquid supplied to a substrate (Tr), the ambient temperature (Tc), the humidity (Hc), and/or the pressure (P) in a coating unit during spin coating as discussed above, the more specific relationship described by the formula:

$$Rt = \alpha (\mu_1 Tr + \mu_2 Tc + \mu_3 Hc + \mu_4 P)$$

where α is a constant and μ_1, μ_2, μ_3, and μ_4 are coefficients describing the degree of contribution for each of Tr, Tc, Hc, and P, respectively, is distinguished over the prior art, which does not teach this specific formula for the resist film thickness, Rt, formed during spin coating.

As allowable subject matter has been indicated, applicant's reply must either comply with all formal requirements or specifically traverse each requirement not complied with. See 37 CFR 1.111(b) and MPEP § 707.07(a).

Response to Arguments

Applicant's arguments with respect to claims 16-23 as currently amended and new claims 24-29 filed 25 August 2003 in Paper No. 9 have been considered but are either moot or not deemed persuasive in view of the maintained and new ground(s) of objection and rejection.

The cancellation of previously withdrawn claims 1-15 has been acknowledged and the newly corrected drawings have been accepted.

Applicants' change of title, as previously suggested, is appreciated.

While applicants have corrected many of the previous errors in the original specification by submission of a corrected substitute specification, numerous errors still remain and are exemplified above.

The currently amended versions of the claims have overcome most of the previous objections. The remaining objection not yet overcome has been restated along with new objections necessitated by amendment.

Currently amended versions of the claims have overcome the previous rejection under the first paragraph of 35 U.S.C. 112 and most of the previous rejections to the pending claims under the second paragraph of 35 U.S.C. 112. The remaining rejections under the second paragraph of 35 U.S.C. 112 are restated above along with new rejections necessitated by amendments to the claims.

Allowable subject matter had been identified in claim 24, but remains rejected due to formal matters, as pointed out above.

With the exception of claim 24, all other amended and new claims are found to be obvious over the cited prior art of record for the reasons explained above.

Conclusion

Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

Any inquiry concerning this communication or earlier communications from the examiner should be directed to John Ruggles whose telephone number is 703-305-7035. The examiner can normally be reached on Monday-Thursday and alternate Fridays.

If attempts to reach the examiner by telephone are unsuccessful, the examiner's supervisor, Mark Huff can be reached on 703-308-2464. The fax phone number for the organization where this application or proceeding is assigned is (703) 872-9306.

Any inquiry of a general nature or relating to the status of this application or proceeding should be directed to the receptionist whose telephone number is 703-308-0661.

J. Ruggles
John Ruggles
Examiner
Art Unit 1756

Mark F. Huff

MARK F. HUFF
SUPERVISORY PATENT EXAMINER
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